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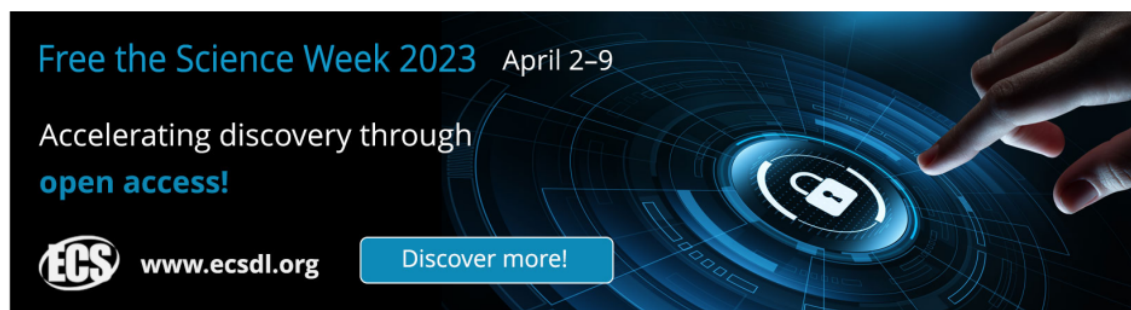
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Improvement of shallot flowering (*Allium cepa* var. *ascalonicum*) of Bauji variety in the lowland area of Jember through vernalization and GA₃ concentrations

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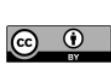
Abstract. Usage of true shallot seed (TSS) can increase onion production. TSS production in the lowlands is still an obstacle by suboptimal flowering of shallots propagated through seed tubers. There are several varieties of shallots that have not been successfully flowered. The treatments of vernalization and administering GA₃ are expected to stimulate the flowering of Bauji variety. The purpose of this study was to improve the flowering of the onion varieties of Bauji in the Jember lowlands (89 m asl). The study was conducted from June to October 2019. The study used a factorial completely randomized block design (CRBD), namely vernalization as the first factor and GA₃ concentration as the second factor with four replications. Data were analyzed using analysis of variance and continued with the Duncan Multiple Range Test (DMRT) at α 5% level. The results showed that independently, vernalization had a significant effect on the parameters of the time the umbel appeared, the percentage of flowering plants, and the number of umbels per plant. Also, vernalization treatment had significantly affected the parameters of the number of flowers per umbel, the number of capsules per umbel, and the percentage of capsule formation per umbel.

5

1. Introduction

Shallot productivity (*Allium cepa* var. *ascalonicum*) in Indonesia were still low at number 10.22 tons / ha (Bapenas 2018) from its potential yields that can reach more than 20 tons / ha. Majority shallot production was produced in the lowlands area with averages of altitude at 100 m above sea level (m asl) and temperatures above 25⁰C. Low number of productivity caused by poor vigor of tuber and contains seedborn diseases. Productivity of shallot could increased by using botanical seeds of shallot called true shallot seed or TSS.

Shallot seeds basically can be produced naturally in the highlands with temperatures below 20⁰C, this is because shallot shall flowering well in these conditions [5]. Therefore, to produce true shallot seed in the lowlands still needs considering that not all varieties of shallots which cultivated in the lowlands could flowering and produces botanical seeds. Generally, initiation of flowering or bolting in the genus *Allium* was influenced by internal and external factors such as plant growth hormone, nutrition, temperature, photoperiodism, rainfalls and water stress. In the tropics, shallot will bloom in the highlands area with temperature at 13⁰ C, but in the lowlands with an average temperature at 27⁰ C shallot become difficult to flowers. [7] reported that induction of flowering in shallot done by vernalization treatment with temperature between 10-15⁰ C, whereas induction flowering of shallot



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was successfully carried out by giving vernalization at 10⁰ C for 4 weeks in the highlands [9]. [3] reported the opposite results that although shallot had been given vernalisation treatment, shallot still could not flowering in Sumenep, Katumi, Bima, Blue and Tiron varieties. The main obstacle for flowering shallots in the lowlands is high temperatures that not suitable for flowering initiation [8]. Therefore, for improve production of shallot seeds of other varieties, especially Bauji varieties, it is necessary to develop research on flowering and improving seed production by providing a combination of treatment between vernalization and GA3 as growth regulators. It was previously known that GA3 can help encourage flowering through manipulation of long day mechanism to induce flowering of short day plants [10], considering that shallot was long day plants that require irradiation > 12 hours (long day plant) [6].

2. Methods

The study was conducted from July to October 2019 at plant experiment garden-State Polytechnic of Jember, Jember, East Java, Indonesia at an altitude of 89 m asl. The experimental design in this study used a factorial randomized block design with 2 factors and four replication. The first factor is vernalization (V), consisting (V0) without vernalization treatment (V1) Vernalization of 5⁰ C for 4 weeks. Second factor is concentration of GA3 (G) which consisting of 0 ppm of GA3 (G0), 50 ppm of GA3 (G1), 100 of GA3 (G2), and 150 ppm of GA3 (G3). Plant material used Bauji as local shallot variety. The data obtained were analyzed by analysis of variance (ANOVA) and DMRT test with $\alpha=5\%$. Parameter observed were time of umbel appearance, percentage of flowering plants, number of umbel per plant, number of flower per umbel, number of capsule per umbel, and percentage of capsule-set per umbel.

3. Result and Discussion

This study was purposed to improve flowering of shallots in the lowland area. There are no interaction between vernalization and GA3 application. Independently, all parameters shown improvement result as respon to vernalization.

3.1 Time of flowering, percentage of plant flowering, and number of umbel per plant

Table 1. Time of flowering, percentage of plant flowering, and number of umbel per plant as response to vernalization and application of GA3 in the lowland area of Jember

Treatments	Time of umbel appearance (DAP)	Percentage of flowering plants (%)	Number of umbel per plant
VxG	Ns	Ns	Ns
Vernalization			
V0	25.63 a	53.75 b	1 b
V1	20.44 b	93.69 a	3 a
Concentration of GA ₃			
G0	22.13	62.25	2
G1	21.13	66.38	2
G2	26.88	74.75	2
G3	22.00	91.50	2

Numbers followed by the same letters within the same column were not significantly different using DMRT at $\alpha = 0,05$. Ns = not significant, DAP = day after planting

There was no significant interaction between vernalization treatment and GA3 concentration on time of flowering, percentage of plant flowering, and number of umbel per plant (Table 1.). Vernalization with a temperature of 5⁰ C for 4 weeks independently significantly able to accelerates time of flowering compared to controls, increased on percentages of plant flowering and improved on number of umbel per plant (Table 1.) (Fig 1.). Vernalization accelerates flowering more than 5 days faster than controls. These result relevant to [1], [3], and [9] whose reported that vernalization was quite effective in induced flowering.



Figure 1. Number of flowers per umbel as respon to non vernalization (a) and vernalization (b)



Figure 2. Number of umbel as respon to vernalization and GA₃ in the lowland area of Jember

In this study vernalization significantly increased percentages of plant flowering up to 93.69%. This result most highest number and improved compare to result from [4] which is only able to produced percentage of plant flowering 50% and [9] with percentage by 29.9 %. Number of umbel that produced by vernalization also greater to reached 3 umbels per plant (Figure 2.) (Table 1). This number is more greater then number of umbels that produced by [4] and [9] in the lowlands area but lower than reported study by [1]. [1] reported that vernalization with temperature 5⁰ C produced until 8 umbels per plant.

3.2 *Number of flower per umbel, number of capsule per umbel, and percentage of capsule-set per umbel*

There was no interaction between vernalization and GA3 concentration on number of flower per umbel, number of capsule per umbel, and percentage of capsule-set per umbel in the lowland area of Jember (Table 2). This result have different result to [2] that reported a combination of applying GA₃ and vernalization promotes flowering and TSS production.

Independently, vernalization can increased number of flower per umbel but does not increase number of capsules and percentages of capsule set. Number of flowers per umbel as respons to vernalization improved significantly with number of flowers per umbel reached 119.39 or increased up to 140.4% compared to research by [4] and 33.65% by [9]. [1] recorded that maximum number of flower per umbel could reached until 250.20 flower. All these reported showed that vernalization was great methods to improved flowering in lowland area which has high temperature.

Meanwhile, number of capsules and percentages of capsules-set as response to vernalization did not increase when compared to plants that were not vernalized. However, number of capsules per umbel and percentage of capsule-set has increased compared to previous studies from [4] and [9]. Number of capsules per umbel reached 40.71 or increased 19% than [9] and 33% than [4]. Percentages of capsule-set reached 40.75% or greater 7% until 13 % than [4] and [9]. According to [9] number of capsule per umbel and percentage of capsule-set influenced by variety and environmental conditions.

Table 2. *Number of flower per umbel, number of capsule per umbel, and percentage of capsule-set per umbels as response to vernalization and application of GA3 in the lowland area*

Treatments	Number of flower per umbel	Number of capsule per umbel	Percentage of capsule-set per umbel
VxG	Ns	Ns	Ns
Vernalization			
V0	80.10 b	44.49 a	45.19 a
V1	119.39 a	40.71 b	40.75 b
Concentration of GA ₃			
G0	121.23	53.20	39.71
G1	104.91	36.64	48.24
G2	86.81	40.47	36.82
G3	86.03	40.09	47.11

Numbers followed by the same letters within the same column were not significantly different using DMRT at $\alpha = 0,05$. Ns = not significant

GA3 concentration have no effect in all flowering parameter. GA3 can not substituted to cold temperature (*bolting*) for induced and promoted flowering in Bauji variety which were planted in the lowland area. This research has the same result as [11] that reported GA3 concentration have no significant effect in all of the observed component. [2] also reported that treatment of GA3 in the lowlands cannot be approved vernalization while on the highland it can change vernalization within increase flowering and TSS production of shallots.

4. Conclusion

The results showed that vernalization had significant effect to improved all flowering parameters of time of umbel appeared, percentages of flowering plants, and number of umbels per plant. Also, vernalization treatment had significantly effected to improved parameters of number of flowers per umbel, number of capsules per umbel, and the percentage of capsule formation per umbel. GA3 cannot replace cold temperature for promoted flowering in Bauji variety.

Acknowledgment

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